

UNCLASSIFIED

F/G 13/13

NIL

1 of 1
AQ 4
125136

END
DATE
FILMED
11-81
DTIC



1.0



1.1



1.25



1.4



1.6

2.8

2.5

3.2

2.2

4.0

2.0



1.8

MICROCOPY RESOLUTION TEST CHART

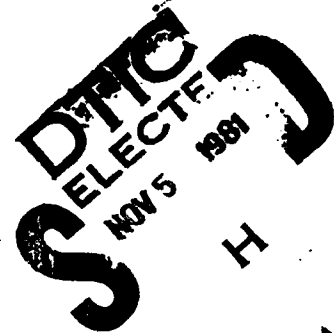
AD A106596

LEVEL



MISSISSIPPI - SALT - QUINCY BASIN

NO NAME 880 DAM
PIKE COUNTY, MISSOURI
MO 31011



PHASE I INSPECTION REPORT NATIONAL DAM SAFETY PROGRAM

DTIC FILE COPY



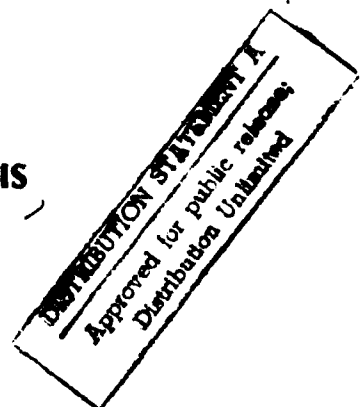
*Original contains color
plates: All DTIC reproductions
will be in black and
white

PREPARED BY: U. S. ARMY ENGINEER DISTRICT, ST. LOUIS

FOR: STATE OF MISSOURI

[Handwritten signature]

DECEMBER 1978



81 11 02 089

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER	2. GOVT ACCESSION NO. AD-A106596	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Phase I Dam Inspection Report National Dam Safety Program No Name 880 Dam (MO 31011) Pike County, Missouri		5. TYPE OF REPORT & PERIOD COVERED Final Report
7. AUTHOR(s) Anderson Engineering, Inc.		6. PERFORMING ORG. REPORT NUMBER
9. PERFORMING ORGANIZATION NAME AND ADDRESS U.S. Army Engineer District, St. Louis Dam Inventory and Inspection Section, LMSED-PD 210 Tucker Blvd., North, St. Louis, Mo. 63101		8. CONTRACT OR GRANT NUMBER(s) DACW43-78-C-0166
11. CONTROLLING OFFICE NAME AND ADDRESS U.S. Army Engineer District, St. Louis Dam Inventory and Inspection Section, LMSED-PD 210 Tucker Blvd., North, St. Louis, Mo. 63101		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)		12. REPORT DATE December 1978
		13. NUMBER OF PAGES Approximately 35
		15. SECURITY CLASS. (of this report) UNCLASSIFIED
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE
16. DISTRIBUTION STATEMENT (of this Report) Approved for release; distribution unlimited.		
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report) National Dam Safety Program. No Name 880 Dam (MO 31011), Mississippi - Salt - Quincy Basin, Pike County, Missouri. Phase I Inspection Report.		
18. SUPPLEMENT		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) Dam Safety, Lake, Dam Inspection, Private Dams		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This report was prepared under the National Program of Inspection of Non-Federal Dams. This report assesses the general condition of the dam with respect to safety, based on available data and on visual inspection, to determine if the dam poses hazards to human life or property.		

DD FORM 1 JAN 73 1473

EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

412554

SECURITY CLASSIFICATION OF THIS PAGE(When Data Entered)

SECURITY CLASSIFICATION OF THIS PAGE(When Data Entered)



DEPARTMENT OF THE ARMY
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
210 NORTH 12TH STREET
ST. LOUIS, MISSOURI 63101

IN REPLY REFER TO

SUBJECT: No Name 880 Dam, MO ID No. 31011

This report presents the results of field inspection and evaluation of No Name 880 Dam. It was prepared under the National Program of Inspection of Non-Federal Dams.

SUBMITTED BY:

SIGNED

Chief, Engineering Division

27 FEB 1979
Date

APPROVED BY:

SIGNED

Colonel, CE, District Engineer

27 FEB 1979
Date

Accession For	
LTTS GRA&I	<input checked="" type="checkbox"/>
ERIC TR	<input type="checkbox"/>
Unannounced	<input type="checkbox"/>
Justification	
By _____	
Distribution/ _____	
Availability Codes	
Avail and/or	Special
Dist	
A	

NO NAME 880 DAM
PIKE COUNTY, MISSOURI
MISSOURI INVENTORY NO. 31011

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

Prepared By
Anderson Engineering, Inc., Springfield, Missouri
Hanson Engineers, Inc., Springfield, Illinois

For
The Governor of Missouri

December, 1978

PHASE I REPORT
NATIONAL DAM SAFETY PROGRAM

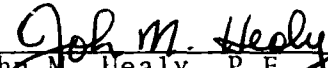
Name of Dam: No Name 880 Dam
State Located: Missouri
County Located: Pike County
Stream: Mud Creek
Date of Inspection: 29 September 1978

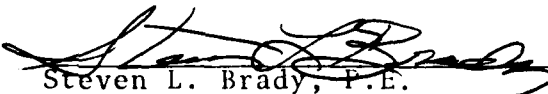
No Name 880 Dam was inspected by an interdisciplinary team of engineers from Anderson Engineering, Inc. of Springfield, Missouri and Hanson Engineers, Inc. of Springfield, Illinois. The purpose of the inspection was to make an assessment of the general condition of the dam with respect to safety, based upon available data and visual inspection, in order to determine if the dam poses hazards to human life or property.

The guidelines used in the assessment were furnished by the Department of the Army, Office of the Chief of Engineers, and have been developed with the help of several Federal and State agencies, professional engineering organizations, and private engineers. Based on these guidelines, this dam has been classified by the St. Louis District Corps of Engineers as an intermediate size dam with a high downstream hazard potential. Their estimate of the potential damage zone extends 6 miles downstream of the dam. Immediately downstream of the dam is one farmhouse with three outbuildings. Also within the potential damage zone are six farm complexes with farmhouses and three improved road crossings.

Our inspection and evaluation indicates that the spillway does not meet the criteria set forth in the guidelines for a dam having the above size and hazard potential. The spillway will pass 15 percent of the Probable Maximum Flood without overtopping. The Probable Maximum Flood is defined as the flood discharge that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region. The guidelines require that a dam of intermediate size with a high downstream hazard potential pass 100 percent of the PMF. The spillway will not pass the 100-year frequency flood without overtopping (15 percent of the PMF is smaller than the 100-year flood). The 100-year frequency flood is one that has a 1 percent chance of being exceeded in any given year.

The embankment and appurtenances inspected appear to be in good condition. However, the unlined spillway presents a potentially dangerous situation that should be corrected. Minor deficiencies, including erosion and possible seepage, were noted and should be corrected by the owner. Other deficiencies are the lack of seepage and stability analysis records, construction plans and cross-section information. A detailed report is attached to be submitted to the owners and to the Governor of Missouri.


John M. Healy, P.E.
Hanson Engineers, Inc.


Steven L. Brady, P.E.
Anderson Engineering, Inc.

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
NO NAME 880 DAM - ID NO. 31011

TABLE OF CONTENTS

<u>Paragraph No.</u>	<u>Title</u>	<u>Page No.</u>
	SECTION 1 - PROJECT INFORMATION	
1.1	General	1
1.2	Description of Project	1
1.3	Pertinent Data	3
	SECTION 2 - ENGINEERING DATA	
2.1	General	5
2.2	Design	5
2.3	Construction	6
2.4	Maintenance	6
2.5	Evaluation	6
	SECTION 3 - VISUAL INSPECTION	
3.1	General	7
3.2	Dam	7
3.3	Reservoir and Watershed	8
3.4	Evaluation	8
	SECTION 4 - OPERATIONAL PROCEDURES	
4.1	Procedures	9
4.2	Maintenance of Dam	9
4.3	Maintenance of Operating Facilities	9
4.4	Description of Any Warning System in Effect	9
4.5	Evaluation	9
	SECTION 5 - HYDRAULIC/HYDROLOGIC	
5.1	Evaluation of Features	10
	SECTION 6 - STRUCTURAL STABILITY	
6.1	Evaluation of Structural Stability	11
	SECTION 7 - ASSESSMENT/REMEDIAL MEASURES	
7.1	Dam Assessment	12
7.2	Remedial Measures	13

APPENDICES

	<u>Sheet</u>
APPENDIX A	
Vicinity Map	1
Plan and Profile of Dam	2
APPENDIX B	
Overtopping Analyses - PMF and 100-Year Frequency Flood	1 thru 8
APPENDIX C	
Photographs of Dam, Lake and Watershed	1 thru 4



Aerial View of Lake and Dam

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL:

A. Authority:

The National Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of safety inspection of dams throughout the United States. Pursuant to the above, the St. Louis District, Corps of Engineers, District Engineer directed that a safety inspection be made of No Name 880 Dam in Pike County, Missouri.

B. Purpose of Inspection:

The purpose of the inspection was to make an assessment of the general condition of the dam with respect to safety, based upon available data and a visual inspection in order to determine if the dam poses hazards to human life or property.

C. Evaluation Criteria:

Criteria used to evaluate the dam were furnished by the Department of the Army, Office of the Chief of Engineers, "Recommended Guidelines for Safety Inspection of Dams." These guidelines were developed with the help of several federal agencies and many state agencies, professional engineering organizations, and private engineers.

1.2 DESCRIPTION OF PROJECT:

A. Description of Dam and Appurtenances:

No Name 880 Dam is an earth fill structure approximately 44 ft high and 900 ft long at the crest. The only spillway associated with the dam is an unlined earth swale (uncontrolled crest) around the north abutment. Earth berms (perpendicular to the axis of the dam) were constructed to attempt to divert any flow away from the downstream face of the dam. Sheet 2 of Appendix A shows a plan and profile of the embankment and a typical section.

B. Location:

The dam is located in the southeast part of Pike County, Missouri on Mud Creek, about 1 mile north of the intersection of highways D and WW. The dam and lake are within the Bowling Green, Missouri-Illinois and Nebo, Illinois-Missouri 15 minute quadrangle sheets, (Twp. 52 N, R1 W-latitude 39° 18', longitude 91° 0'). Sheet 1 of Appendix A shows the general vicinity and location of the dam. It should be

noted that the location of this dam is different from that described in the Corps of Engineers' inventory. The inventory information indicates that the dam is located at latitude 39° 16.9', longitude 90° 58.5'. The height of the dam is listed as being 65 ft, and normal storage capacity is 960 acre-ft.

C. Size Classification:

With an embankment height of 44 ft and a maximum storage capacity of approximately 350 acre-ft, the dam is in the intermediate size category.

D. Hazard Classification:

The St. Louis District, Corps of Engineers has classified this dam as a high hazard dam. Their estimate of the damage zone extends 6 miles downstream of the dam. Immediately downstream of the dam is one farmhouse with three outbuildings. Also within the damage zone are six farm complexes with farmhouses and three improved road crossings.

E. Ownership:

The dam is privately owned by Mr. Chester Lockard, Route 4, Eolia, Missouri, 63344.

F. Purpose of Dam:

It is reported that the dam and lake were to be a part of a housing development. However, the lake is currently used to water livestock; some flood protection is also provided.

G. Design and Construction History:

No design information is available. The dam was constructed by the Warren Magruder Construction Company of Eolia, Missouri and completed in 1973. Plans for construction are not available. Therefore, it is not known if any internal drainage features are available to moderate or control the seepage that was noted. Although an earth berm was provided on the upstream face for riprap, none was placed. No significant problems concerning seepage through or stability of the embankment are reported to have occurred since the dam was built. However, there was an indication of seepage downstream from the toe of the dam. To our knowledge, no modifications have been made since the original construction.

H. Normal Operating Procedure:

All flows will be passed by an uncontrolled grass-covered spillway. Information from a nearby resident indicates that the spillway has never been used, and the lake level is the highest that it has ever been.

1.3 PERTINENT DATA:

Pertinent data about the dam and reservoir are presented in the following paragraphs. Sheet 2 of Appendix A is a plan of the embankment and spillway with a profile of the dam.

A. Drainage Area:

The drainage area for this dam, as obtained from the Bowling Green, Missouri-Illinois and Nebo, Illinois-Missouri 15 minute quad sheets, is equal to approximately 148 acres.

B. Elevations (Feet Above M.S.L.):

- (1) Top of Dam (measured): South End 719.5; Center 723.1; North End 720.1.
- (2) Spillway Crest: Measured 717.9.
- (3) Pool on Date of Inspection: Measured 715.1.
- (4) High Water Mark: Reported 715.1.
- (5) Streambed at Centerline of Dam: Measured 679.4.
- (6) Maximum Tailwater: Unknown.

C. Discharge at Dam Site:

- (1) All discharge at the dam site is through an uncontrolled spillway.
- (2) Estimated Discharge Capacity at Top of Dam (El. 719.5): 116 cfs.

D. Reservoir Surface Areas:

- (1) At Spillway Crest: 17 acres.
- (2) At Top of Dam: 19.4 acres.

E. Storage Capacities:

- (1) At Principal Spillway Crest: 323 acre-ft.
- (2) At Top of Dam (El. 719.5): 350 acre-ft.

F. Reservoir Lengths:

- (1) At Principal Spillway Crest (Estimated from Topographic Map): 1400 ft.
- (2) At Top of Dam (Estimated from Topographic Map): 1600 ft.

G. Dam:

- (1) Type: Rolled earth.
- (2) Length at Crest: 900 ft.
- (3) Height: 44 ft.
- (4) Top Width: 25 ft.
- (5) Side Slopes: 3.5H:1V downstream; 3.0H:1V upstream.
- (6) Zoning: Homogeneous.
- (7) Cutoff: Shallow core trench (depth and width unknown).

H. Spillway:

- (1) Location: North end of dam.
- (2) Type: Grass-covered earth with 5 ft crest length and irregular side slopes.

SECTION 2 - ENGINEERING DATA

2.1 GENERAL:

No design computations or reports for No Name 880 Dam are available. No documentations of construction inspection records have been obtained. There are no documented maintenance data to our knowledge.

2.2 DESIGN:

A. Surveys:

No information regarding pre-construction surveys was able to be obtained. Sheet 2 of Appendix A presents information about the benchmark which was used for the site survey.

B. Geology and Subsurface Materials:

The topography around the site can be described as rolling to hilly. The subsurface materials in upland areas generally consist of about 10 ft of loess underlain by residual soils and bedrock. Geological maps of the area indicate that the bedrock is the Kimmswick formation of the Champlainian series of the Ordovician system. The Kimmswick formation is typically a coarsely crystalline, white to light gray, medium bedded to massive limestone.

C. Foundation and Embankment Design:

No foundation and embankment design information was available. Seepage and stability analyses were not performed as required in the guidelines. The contractor who constructed the dam said that in order to cut off a gravel deposit, a core trench was constructed at the base of the dam along its entire length. There is apparently no particular zoning of the embankment, and no internal drainage features are known to exist. No construction inspection test results have been obtained.

D. Hydrology and Hydraulics:

No hydrologic and hydraulic computations were performed in the design of No Name 880 Dam. Based on a field check of spillway dimensions and embankment elevations, and a check of the drainage area on U.S.G.S. quad sheets, hydrologic analyses using U.S. Army Corps of Engineers guidelines were performed and appear in Appendix B, Sheets 1 to 8. It was concluded that the spillway will pass 15 percent of the Probable Maximum Flood.

E. Structure:

There are no appurtenant structures associated with this dam.

2.3 CONSTRUCTION:

No construction inspection data have been obtained.

2.4 MAINTENANCE:

The visual inspection indicates that cattle grazing on and around the dam are effective in keeping grass and brush from overgrowing.

2.5 EVALUATION:

No engineering data, seepage or stability analyses, or construction test data comparable to the requirements of "Recommended Guidelines for Safety Inspection of Dams" were available. Thus, the available information was inadequate to make a detailed assessment of the design, construction and operation. No valid engineering data on design or construction of the embankment were found.

SECTION 3 - VISUAL INSPECTION

3.1 GENERAL:

The field inspection was made on 29 September 1978. The inspection team consisted of personnel from Anderson Engineering, Inc. of Springfield, Missouri and Hanson Engineers, Inc. of Springfield, Illinois. The team members were:

Louis Williams - Anderson Engineering, Inc. (Instrument Man)
Steve Brady - Anderson Engineering, Inc. (Civil Engineer)
Dan Kerns - Hanson Engineers, Inc. (Geotechnical Engineer)
Dave Daniels - Hanson Engineers, Inc. (Geotechnical and
Hydraulics Engineer)

3.2 DAM:

The dam is an earth fill embankment. Borrow material was apparently obtained from the abutments and reservoir area. Based on available surficial soil information for the area, the fill material would be expected to consist of low to medium plasticity clays and silts.

The embankment is grass-covered and appears to be in good condition. No sloughing of the embankment or seepage through the embankment was evident. No animal burrows were noted. There was some slight erosion at the contact of the dam and the south abutment.

An area of seepage was noted beyond the toe of the dam at the south abutment (See photos on Sheet 4 of Appendix C). The flow through a culvert under the road to the east was estimated to be between 1 and 2 gpm (only apparent source for the flow was from the seepage area). For the most part, the seepage appears to be passing through the abutment downstream of the dam. However, one small wet area was noted very near to the abutment-dam contact.

The horizontal alignment was good. A depression in the embankment was noted near the south end of the dam. No surface cracking or unusual movement was observed. The absence of riprap has allowed some erosion of the upstream face of the dam.

No instrumentation (monuments, piezometers, etc.) was observed.

A. Spillway:

The spillway was in good condition. There was no brush or weed growth in the spillway area.

3.3 RESERVOIR AND WATERSHED:

The immediate periphery of the lake was grass- and timber-covered with moderate slopes. No sloughing or serious erosion of reservoir banks was noted, although some erosion of the upstream face of the dam was noted.

3.4 EVALUATION:

If the unlined, unprotected spillway is used, then considerable erosion of the north abutment and abutment-dam contact would occur. This erosion could seriously affect the stability of the embankment. To prevent this, the spillway should be modified to guard against erosion.

A long-time resident and former owner of the property stated that the area of seepage at the south abutment beyond the toe of the dam is actually a spring which has been active since long before the dam was built. He also reported that there are several small springs which feed the lake, some of which are now within the reservoir area. Although it is believed that the seepage is passing through the abutment and not the embankment, the seepage should be monitored as a precaution.

Minor erosion noted at the contact of the south abutment, if left uncontrolled or uncorrected, could lead to serious problems in the future. Wave protection should be provided for the upstream face of the dam.

Photographs of the dam and the reservoir and watershed are presented in Appendix C.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES:

Since there are no controlled outlet works for this dam, no regulating procedures exist. The pool is normally controlled by rainfall, runoff and evaporation. The capacity of the uncontrolled spillway is also available, although it apparently has not been used to date.

4.2 MAINTENANCE OF DAM:

No maintenance information was available. The visual inspection indicates that cattle grazing on and around the dam are effective in keeping grass and brush from overgrowing.

4.3 MAINTENANCE OF OPERATING FACILITIES:

No operating facilities exist for this dam.

4.4 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT:

The inspection team is unaware of any existing warning system for this dam.

4.5 EVALUATION:

The unprotected, unlined spillway is a serious deficiency which should be rectified. If the existing spillway is used, then considerable erosion could occur at the north abutment and abutment-dam contact so that the stability of the embankment is endangered. Any tree and brush growth should be removed from the dam and outlet channel on a yearly basis. Erosional areas as previously discussed should be repaired. Erosion control measures, such as rip-rap should be used to prevent future erosion on the upstream face of the dam. The seepage from the spring beyond the toe of the dam should be monitored as a precaution.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES:

A. Design and Experience Data:

No design computations were obtained. A long-time resident stated that the spillway has never been used, and that the water level is as high as it has ever been. Based on a field check of spillway dimensions and embankment elevations and a check of the pool and drainage areas from U.S.G.S. quad sheets (Bowling Green, Missouri-Illinois and Nebo, Illinois-Missouri quad sheets), hydrologic analyses using U.S. Army Corps of Engineers guidelines were performed and appear in Appendix B, Sheets 1 to 8.

B. Visual Observations:

The earth- and grass-covered spillway is in good condition. The spillway is located on the north abutment, and has apparently never been used. However, flows over this unlined and unprotected spillway could endanger the integrity of the dam.

C. Overtopping Potential:

The crest elevation of the dam varies considerably. For a more realistic overtopping analysis, the existing shape of the crest of the dam, obtained by surveying, was used in the computation of the rating curve for the dam. Based on the hydrologic and hydraulic analyses as presented in Appendix B, the spillway will pass 15 percent of the Probable Maximum Flood. The Probable Maximum Flood is defined as the flood discharge that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region. The recommended guidelines from the Department of the Army, Office of the Chief of Engineers, require that this structure (intermediate size with high downstream hazard potential) pass 100 percent of the PMF, without overtopping. Fifty percent of the PMF will overtop the dam by 1.13 ft for a duration of 5.42 hours with a resultant peak outflow discharge of 1038 cfs. One hundred percent of the PMF will overtop the dam by 1.90 ft for a duration of 7.50 hours with a resultant peak outflow of 2348 cfs (see Sheet 6 of Appendix B). The structure will pass only 88 percent of the 100-year frequency flood without overtopping. One hundred percent of the 100-year frequency flood will overtop the dam by 0.14 ft for a duration of 0.92 hours with a resultant peak outflow of 176 cfs (see Sheet 8 of Appendix B).

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY:

A. Visual Observations:

Flows passing over the existing spillway would be expected to cause considerable erosion at the north abutment or abutment-dam contact. The spillway should be modified to guard against erosion.

If left unchecked, the erosion at the south abutment-dam contact could cause some localized stability problems in the future. In addition, wave protection should be provided for the upstream face of the dam to check the erosion in that location. The seepage (spring) at the south abutment, although apparently not associated with the dam and lake, should be monitored with respect to quantity of seepage and turbidity.

B. Design and Construction Data:

No design and construction data for the foundation and embankment were obtained. Seepage and stability analyses comparable to the requirements of the guidelines are lacking and constitute a deficiency that should be rectified.

C. Operating Records:

There are no operating facilities at the dam.

D. Post-Construction Changes:

The inspection team is not aware of any post-construction changes to the dam.

E. Seismic Stability:

The structure is located in seismic zone 1, which is historically the least active zone in terms of occurrence and magnitude of earthquakes. The seismic loading prescribed for zone 1 is generally not critical for a well-constructed earth dam of this size.

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 DAM ASSESSMENT:

A. General:

This Phase I inspection and evaluation should not be considered as being comprehensive since the scope of work contracted for is far less detailed than would be required for an in-depth evaluation of dams. Latent deficiencies, which might be detected by a totally comprehensive investigation, could exist.

B. Safety:

The embankment itself is generally in good condition. The minor items which have been noted previously--such as erosion--can and should be corrected and controlled. Additional deficiencies include an inadequate, unlined spillway and lack of seepage and stability analyses. The presence of seepage below the toe of the dam is a minor deficiency, but an increase in flow or turbidity could be evidence of incipient piping failure.

The dam will be overtopped by flows in excess of 15 percent of the Probable Maximum Flood and 88 percent of the 100-year frequency flood. Overtopping of an earthen embankment could cause serious erosion and could possibly lead to failure of the structure.

C. Adequacy of Information:

The conclusions in this report were based on this site survey, the performance history as related by others and visual observation of external conditions. The inspection team considers that these data are sufficient to support the conclusions herein. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines" were not available, which is a deficiency.

D. Urgency:

The remedial measures recommended in paragraph 7.2 should be accomplished in the near future. If the deficiencies listed in paragraph B are not corrected, and if good maintenance is not provided, the embankment condition will continue to deteriorate and possibly could become serious in the future. Priority should be given to increase the capacity of the spillway by widening it and/or increasing the height of the dam. In addition, the spillway should be modified to guard against erosion.

E. Necessity for Phase II:

Based on the result of the Phase I inspection, no Phase II inspection is recommended.

F. Seismic Stability:

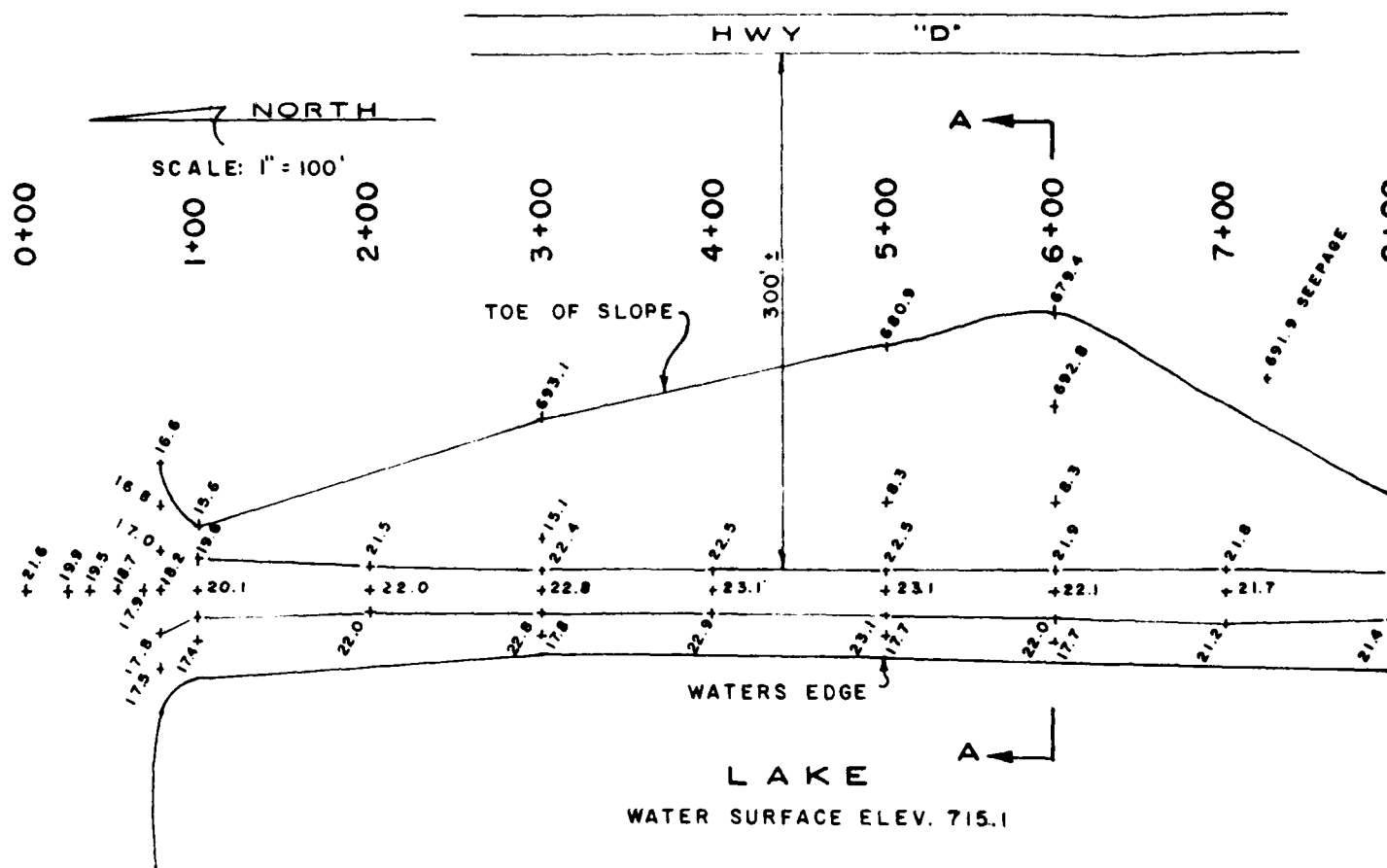
The structure is located in seismic zone 1, which is historically the least active zone in terms of occurrence and magnitude of earthquakes. The seismic loading prescribed for zone 1 is generally not critical for a well-constructed earth dam of this size.

7.2 REMEDIAL MEASURES:

The following remedial measures and maintenance procedures are recommended and should be performed under the guidance of a professional engineer experienced in the design and construction of dams:

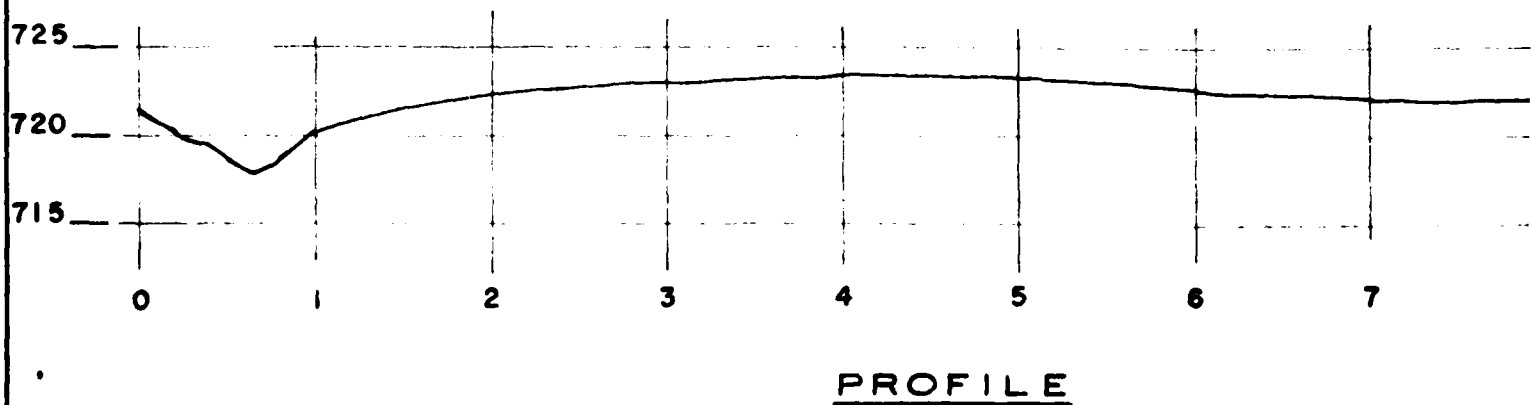
- (1) The spillway size and/or the height of the dam should be increased to pass the PMF.
- (2) The spillway should be modified to guard against erosion.
- (3) Wave protection should be provided for the upstream face of the dam.
- (4) The seepage at the south abutment beyond the toe of the dam should be monitored with respect to quantity of seepage and turbidity. Although this seepage apparently is not serious at this time, it could develop to a point where the stability of the dam is threatened.
- (5) Seepage and stability analyses comparable to the requirements of the guidelines were not available, which is considered a deficiency and should be corrected.
- (6) Correct the minor erosion at the south abutment-dam contact.
- (7) Check the downstream slope periodically for seepage and stability problems. If wet areas or seepage flows from the embankment are observed, or if sloughing is noted, then the dam should be inspected and the situation evaluated by an engineer experienced in design and construction of dams.
- (8) A detailed inspection of the dam should be made at least every 5 years by an engineer experienced in the design and construction of dams. More frequent inspections may be required if slides, seepage areas, or other items of distress are observed.

APPENDIX A

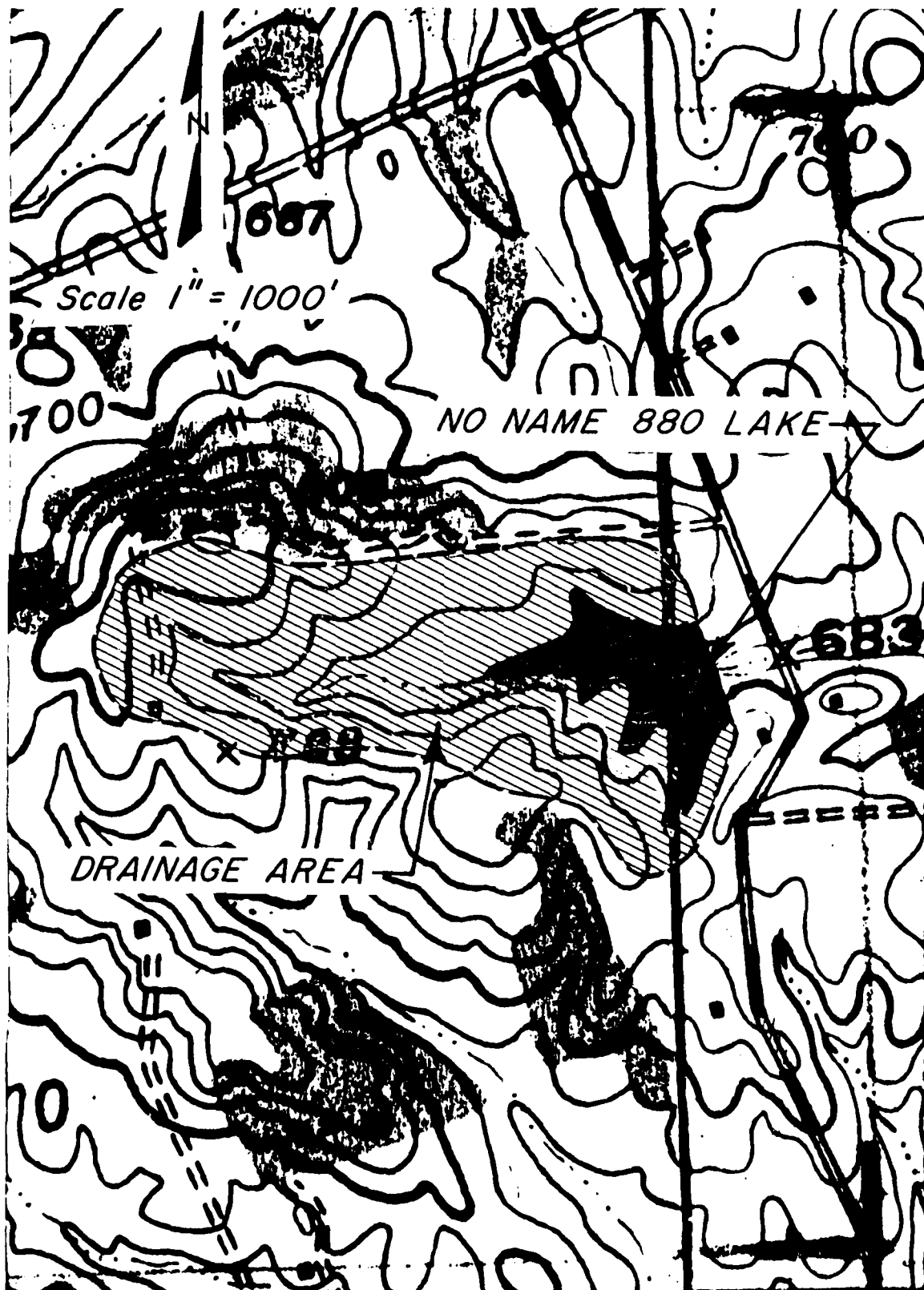


BENCHMARK:

UE 1 C, 2.5 mi. N. ALONG COUNTY RTE D, FROM TABLET, 12 ft N. AND 30 ft E OF CI OF ROAD AT FIELD ENTRANCE E, NEAR THE CREST OF A HILL IN THE E. SIDE OF A PO AND 0.8 ft ABOVE GROUND LEVEL, A RR SPIKE. ELEV. = 733.81



APPENDIX B



Sheet 1 , Appendix B

HYDRAULIC AND HYDROLOGIC DATA
NO. 880 DAM

Design Data: From Field Measurements and Computations

Experience Data: No records are available. The dam was built 5 years ago by Magruder Construction Co. Mr. Edwards, former owner of the land, stated on the day of inspection that the reservoir level was the highest it had ever been. The level has risen several feet over the last few years, but the spillway has never operated.

Visual Inspection: At the time of inspection, the pool elevation was 715.07, or about 3 ft below normal pool (elev. 718.00).

Overtopping Potential: Flood routings were performed to determine the overtopping potential. Since the dam is of intermediate size with a high hazard rating, a spillway design storm of 100 percent PMF was prescribed by the guidelines. The watershed drainage and the reservoir surface areas were obtained by planimetry of a blow-up of the areas made from the U.S.G.S. 15 minute Bowling Green, Mo. and Nebo, Mo. quadrangle maps. The storage volume was developed from these data.

A 5 minute interval unit graph was developed for this watershed, which resulted in a peak inflow of 609 c.f.s. and a time-to-peak of 10 minutes. Application of the probable maximum precipitation minus losses resulted in a flood hydrograph peak inflow of 2940 c.f.s. Rainfall distribution for the 24 hour storm was in accordance with EM 1110-2-1411.

The crest elevation of the dam varies considerably. For a more realistic overtopping analysis, the existing shape of the crest of the dam, obtained by surveying, was used in the computation of the rating curve for the dam. Considering the top of the dam at the lowest portion of the crest (elev. 719.5), the combination of dam, spillway and storage is not sufficient to pass the PMF (nor the 100 year flood) without overtopping the embankment. The PMF would overtop the crest by 1.90 ft (elev. 721.40). The routing of the PMF indicates that if the lowest portion of the dam was raised from elev. 719.5 to elev. 722.5 (average elevation of the crest), the spillway would be sufficient to pass more than 50 percent of the PMF without overtopping. To accomplish this, it is also recommended that the portion of the embankment beside the spillway be raised to protect the north abutment of the dam.

Fifty percent of the PMF was routed through the spillway. The resultant maximum pool elevation was 720.63 ft, which is 1.13 ft above the lowest elevation of the crest of the dam (elev. 719.50). The portion of the PMF that will just reach the top of the dam is about 15 percent. The 100 year flood was also routed through the spillway, resulting in an overtopping of 0.14 ft above the lowest portion of the crest of the dam. For additional information, see the "Summary of Dam Safety Analyses" on Sheets 3 and 4.

OVERTOPPING ANALYSIS FOR No. 880 Dam

INPUT PARAMETERS

1. Unit Hydrograph - SCS Dimensionless - Flood Hydrograph Package (HEC-1, Dam Safety Version) was Used.
Hydraulic Inputs Are As Follows:
 - a. Twenty-four Hour Rainfall of 25 Inches
For 200 Square Miles - All Season Envelope
 - b. Drainage Area = 147.5 Acres; = 0.23 Sq. Miles
 - c. *Travel Time of Runoff 0.226 Hrs.; Lag Time 0.14 Hrs.
 - d. Soil Conservation Service Runoff Curve No. 80 (AMC-III)
Hydrologic Soil Group B
 - e. Proportion of Drainage Basin Impervious 0.11
2. Spillways
 - a. Primary Spillway: Trapezoidal Section
(Crest Elev. = 718.0)
Length 5 Ft. (bottom); Side Slopes irregular; C = 2.65
 - b. Emergency Spillway: None
 - c. Dam Overflow (through lowest portion of the crest)
Length 15 Ft.; Side Slopes irregular; C = 5.0

Note: Combined Spillway and Dam Rating Curve, Prepared
by Hanson Engineers. Data Provided to Computer on
Y4 and Y5 Cards.

SUMMARY OF DAM SAFETY ANALYSIS

1. Unit Hydrograph
 - a. Peak - 609 c.f.s.
 - b. Time to Peak 10 Min.
2. Flood Routings Were Computed by the Modified Puls Method
 - a. Peak Inflow (see Sheet 6)

50% PMF 1470 c.f.s.; 100% PMF 2940 c.f.s.

*Equation $T_c = (11.9 L^3)^{0.385}$, From California Culvert Practice,
California Highways and Public Work, Sept., 1942

b. Peak Elevation

50% PMF 720.63 100% PMF 721.40

c. Portion of PMF That Will Reach Top of Dam

15 %; Top of Dam Elev. (Varies) 719.50 Ft. (Lowest Point)

3. Computer Input and Output Data Sheets for the PMF and 100 Yr. Flood are shown in Sheets 5, 6, 7 and 8.

PAGE 0001

NO. 880 DAM (PROBABLE MAXIMUM FLOOD)

A OVERTOPPING ANALYSIS FOR NO. 880 DAM (#1) (HEC-1) DAM SAFETY
 A CO CODE 163 CO NAME PIKE STATE ID NO NO 31011 OWNER CHESTER LOCKARD
 A HANSON ENGINEERS INC. DAM SAFETY INSPECTION (JOB #03778)

B	300		5					
B1	5							
J	1	8	1					
J1	0.10	0.15	0.20	0.30	0.4	0.5	0.60	1.00
K	0	1			0	0	1	
K1	INFLOW HYDROGRAPH COMPUTATION							
M	1	2	0.23		0.23	1		1
P	0	25	102	120	130			
T							-1	-80
U2	0.23	0.14						0.11
X	0	-1	2					
K	1	2						1

K1 RESERVOIR ROUTING BY MODIFIED PULS AT NO. 880 DAM

Y			1	1			
Y1	1					323	-1
Y4	718	719	719.5	720	721	722	722.5
Y5	0	43	116	323	1453	3681	7745
SS	323	396					
SE	718	722					
SS	718						
SD	719.5						
K	99						

0001

1) (HEC-1) DAM SAFETY
1011 OWNER CHESTER LOCKARD
INSPECTION (JOB #03778)

0.60 1.00
1

-1 -80 0.11

1
280 DAM

323
722.5
7745

Sheet 5, Appendix B

1.2

***** PAGE 0001

1

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO E
 FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SE
 AREA IN SQUARE MILES (SQUARE KILOMETERS)

NO. 880 DAM (PROBABLE MAXIMUM FLOOD)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS				RAT
				RATIO 1 0.10	RATIO 2 0.15	RATIO 3 0.20	RATIO 4 0.30	
HYDROGRAPH AT	1	0.23	1	294.	441.	588.	882.	
	(	0.60)	(	8.33)(	12.49)(	16.65)(	24.98)(	31
ROUTED TO	2	0.23	1	50.	110.	229	525.	
	(	0.60)	(	1.42)(	3.11)(	6.48)(	14.88)(	21

1

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1

ELEVATION
STORAGE
OUTFLOW

INITIAL VALUE

718.00
323.
0.

SPILLWAY CREST

718.00
323.
0.

T

RATIO OF PMF	MAXIMUM RESERVOIR W.S. ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TO HOURS
0.10	719.05	0.00	342.	50	0.00
0.15	719.46	0.00	350.	110	0.00
0.20	719.77	0.27	355.	229	1.58
0.30	720.18	0.68	363.	525	3.00
0.40	720.42	0.92	367	900	4.42
0.50	720.63	1.13	371	1038	5.42
0.60	720.83	1.33	375	1262	6.08
1.00	721.40	1.90	385	2348	7.50

FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
 SECOND (CUBIC METERS PER SECOND)
 ES (SQUARE KILOMETERS)

RATIOS APPLIED TO FLOWS

2	RATIO 3	RATIO 4	RATIO 5	RATIO 6	RATIO 7	RATIO 8
5	0.20	0.30	0.40	0.50	0.60	1.00
	588.	882.	1176.	1470.	1764.	2940.
>	16.65>	24.98>	33.31>	41.63>	49.96>	83.26>
	229	525.	800.	1038.	1262.	2348.
>	6.48>	14.88>	22.66>	29.39>	35.73>	66.49>

OF DAM SAFETY ANALYSIS

SPILLWAY CREST	TOP OF DAM
718.00	719.50
323.	350.
0.	116.

NUM PAGE	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
42.	50.	0.00	17.08	0.00
50.	110.	0.00	16.17	0.00
55.	229.	1.58	16.00	0.00
63.	525.	3.00	15.83	0.00
67.	800.	4.42	15.83	0.00
71.	1038.	5.42	15.83	0.00
75.	1262.	6.08	15.83	0.00
85.	2348.	7.50	15.75	0.00

OVERTOPPING ANALYSIS FOR THE 100-YEAR FLOOD
 CODE 163 CO. NAME
 HANSON ENGINEERS INC.

[illegible]

02	0	23	0	14				
		0	-0.1		2			
		1	2					1
01	RESERVOIR ROUTING BY MODIFIED PULS AT NO 890 DAM							
					1	1		
01		1						323
04	719	719	719.5	720	721	722	722.5	
05	0	43	116	127	1453	7681	7745	
06	323	396						
08	719	722						
09	719							
10	719.5							
11	44							

00e	00e	00e	00e
00e			
00e			
00e	00e	00e	00e
00e	00e	00e	00e
00e	00e	00e	00e
00e	00e	00e	00e
017	017	017	017
017	017	017	017
017	017	017	017
017	017	017	017
027	027	027	027
028	028	028	028
058	058	127	127
141	128	127	127
028	028	028	028
023	023	023	023
023	023	023	023
013	013	013	013
013	013	013	013
013	013	013	013
006	006	006	006
006	006	006	006
006	006	006	006
006	006	006	006
006	006	006	006
006	006	006	006
006	006	006	006
-1	-80		0 11

Sheet 7, Appendix B

12

***** PAGE 0001

10 100 DAM-100 YR. FLOOD

PEAK FLOW AND STORAGE (END OF PERIOD) (CFS) (AC-FT) (PLAN-FT)
 FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER
 AREA IN SQUARE MILES (SQUARE KILOMETERS))

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO F			
				RATIO 1	RATIO 2	RATIO 3	RATIO 4
				0.70	0.80	0.90	1.00
HYDROGRAPH AT	1	0.23	1	536	613	690	766
	(	0.60)	(	15.19)	17.36)	19.53)	21.70)
ROUTED TO	2	0.23	1	77	99	127	176
	(	0.60)	(	2.19)	2.80)	3.60)	4.97)

1

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1	ELEVATION	INITIAL VALUE	SPILLWAY CREST
	STORAGE	718.00	718.00
	OUTFLOW	323.	323.
		0.	0

RATIO OF PMF	MAXIMUM RESERVOIR W. S. ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DUR OVE HQ
0.70	719.23	0.00	346	77	0
0.80	719.38	0.00	348	99	0
0.90	719.53	0.03	351	127	0
1.00	719.64	0.14	353	176	0

MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
 (CUBIC METERS PER SECOND)
 (SQUARE KILOMETERS)

RATIOS APPLIED TO FLOWS

RATIO 3 RATIO 4
 0.90 1.00

690 766.
 19.53X 21.70X

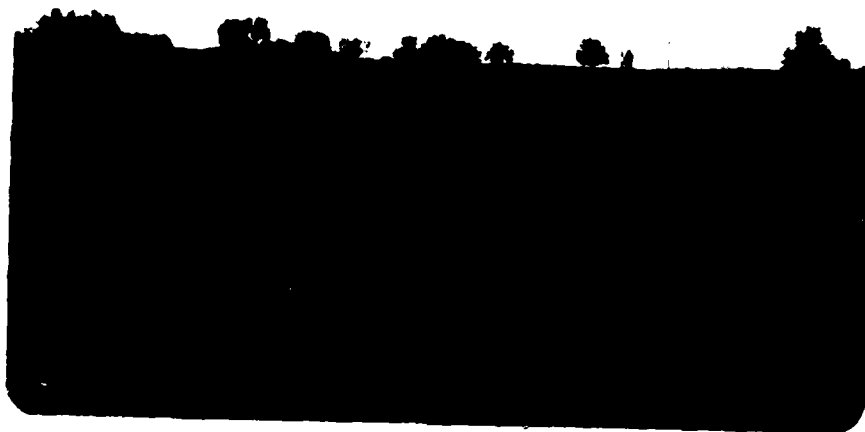
127 176.
 3.60X 4.97X

DAM SAFETY ANALYSIS

SPILLWAY CREST	TOP OF DAM
718.00	719.50
323.	350.
0.	116.

MAXIMUM	DURATION	TIME OF	TIME OF
OUTFLOW	OVER TOP	MAX OUTFLOW	FAILURE
CFS	HOURS	HOURS	HOURS
77	0 00	12.83	0 00
99	0 00	12.75	0 00
127	0 42	12.75	0 00
176	0 92	12.67	0 00

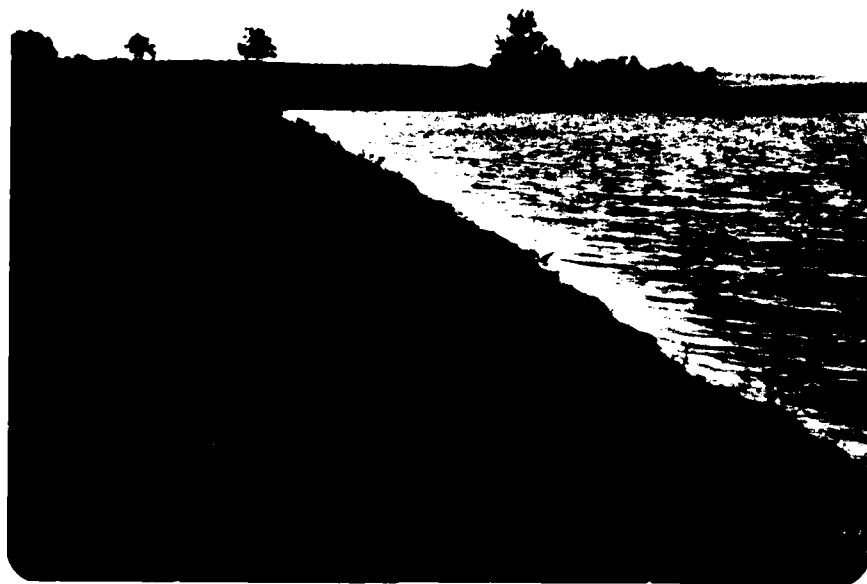
APPENDIX C



Downstream Face of Embankment - Looking South



Crest of Embankment - Looking South



Upstream Face of Embankment - Looking South



View of Lake and Dam - Looking South



Spillway - Looking Upstream



Spillway - Looking Downstream



Area of Seepage - Looking From Top of Dam



Area of Seepage - Looking Toward Dam

DAT
ILM